

Wood, and further in view of Ohkubo et al. (United States Patent Number 6,151,369). Claims 5-10 were rejected under 35 U.S.C. §103(a) as being unpatentable over Dejonghe in view of Rakib et al., Bohnke, Wood, and further in view of Klank et al. (United States Patent Number 6,226,337). Claim 11 was rejected under 35 U.S.C. §103(a) as being unpatentable over Dejonghe in view of Rakib et al., Bohnke, Wood, and further in view of Van Nee (United States Patent Number 6,404,732). Claims 12-30 were rejected under 35 U.S.C. §103(a) as being unpatentable over Dejonghe in view of Rakib et al., Bohnke, Wood, and further in view of Ohkubo, Klank and Van Nee.

The present invention is directed to techniques for estimating the frequency offset and interleaver synchronization in an OFDM communication system. Certain locations in an OFDM frame, such as adjacent bins, are allocated to a signature sequence. Data is differentially encoded in frequency, so that said frequency offset and interleaver synchronization can be estimated from a single OFDM frame. The frequency offset is estimated at a receiver by determining whether a correlated peak associated with said signature sequence is in an expected location. A beginning of an interleaver block is identified based on a location of a correlated peak associated with the signature sequence.

Independent Claims 1, 12, 22, 29 and 30

Independent Claims 1-3 were rejected under 35 U.S.C. §103(a) as being unpatentable over Dejonghe in view of Rakib et al., and further in view of Bohnke and Wood.

The Examiner asserts that Wood teaches that “the return link, with preamble and Barker code, is differential phase shift key modulated onto subcarrier of 596.1 KHz (col. 14, lines 15-47).”

Applicants acknowledge that Wood teaches that the return link data is differential phase shift key modulated. Each of the independent claims of the present invention emphasize that differential encoding/decoding of the signature sequence is performed in *frequency*.

Thus, Wood does not disclose or suggest “transmitting said signature sequence with data to a receiver wherein said data and signature sequence are encoded using a differential encoding performed in frequency,” as required by independent claims 1 and 22. Similarly, Wood does not disclose or suggest “wherein said received digital signal (that contains a signature sequence in an

expected location) is encoded using a differential encoding performed in frequency,” as required by independent claims 12, 29 and 30.

The Examiner further asserts that Dejonghe discloses a method for estimating the frequency offset in an OFDM communication system, comprising the steps of: allocating certain  
5 locations to a signature sequence (Citing Figs. 1 and 2); transmitting said signature sequence with data to a receiver; and estimating the frequency offset at said receiver by determining whether a correlated peak associated with said signature sequence is in an expected location.

Furthermore, the Examiner asserts that Bohnke teaches the transmitting and receiving of the power control information in the slot frames of the OFDM system “using a differential method  
10 to modulate the data for the power control information (abstract). The information transmitted including the phase reference information (signature sequence) and the power control information (differentially encoded data).”

Applicants acknowledge that Bohnke transmits the power control information using a differential method. The phase reference information, however, which the Examiner compares to the  
15 signature sequence of the present invention, is not transmitted using a differential method. Bohnke teaches “one of said subcarriers, for example the first subcarrier in a respective number of subcarriers...carries a phase reference information, if the information is differential phase modulated.” Col. 1, lines 40-44. Thus, if the data being transmitted is differential phase modulated, the phase reference information is transmitted on one of the subcarriers. For example, Figure 1  
20 shows “the first subcarrier shown in said frequency slot is a phase reference subcarrier 1 carrying a phase reference information...(and) the second subcarrier 2 carries a differential encoded power control information.” Col. 1, lines 52-56. Thus, Bohnke does not disclose or suggest “transmitting said signature sequence with data to a receiver wherein said data *and said signature sequence* are encoded using a differential encoding performed in frequency,” as required by independent claims 1  
25 and 22, and does not disclose or suggest “wherein said received digital signal (that contains a signature sequence in an expected location) is encoded using a differential encoding performed in frequency,” as required by independent claims 12, 29 and 30.

In addition, as shown in FIGS. 1 and 2, Dejonghe differentially encodes the signal in *time* (vertically in FIG. 1), by comparing corresponding bins (or carriers) of two adjacent frames (or symbols)  $C_0$  and  $C_1$ . Thus, a single frame (or symbol) cannot be decoded at the receiver until the second frame arrives. In addition, the frequency offset cannot be determined unless multiple frames are received. See, also, mathematical expression 1, at col. 4, line 34, where it is clear that the differential value is  $C_1$  multiplied by the complex conjugate of  $C_0$ .

As previously stated, each of the independent claims of the present invention emphasize that differential encoding/decoding of the signature sequence is performed in frequency. Therefore, the present invention allows the frequency offset to be estimated from a single frame. In other words, the present invention encodes the data and signature sequence of a single frame differentially across the bins (or subcarriers) in frequency, while Dejonghe encodes data differentially between the bin of one frame and the corresponding bin of another frame.

Thus, Dejonghe does not disclose or suggest “transmitting said signature sequence with data to a receiver wherein said data and signature sequence are encoded using a differential encoding performed in frequency,” as required by independent claims 1 and 22. Similarly, Dejonghe does not disclose or suggest “wherein said received digital signal (that contains a signature sequence in an expected location) is encoded using a differential encoding performed in frequency,” as required by independent claims 12, 29 and 30.

#### Additional Cited References

Rakib has been cited by the Examiner for its disclosure of details on an interleaver. Rakib does not disclose or suggest techniques for estimating the frequency offset or interleaver synchronization in an OFDM communication system, using differential decoding in frequency.

Ohkubo has been cited by the Examiner for its disclosure of frequency offset correction in an OFDM communication system. Ohkubo does not disclose or suggest techniques for estimating the frequency offset or interleaver synchronization in an OFDM communication system, using differential decoding in frequency.

Klank has been cited by the Examiner for its disclosure of transmitting digital frames using multiple modulated carriers having a given reference frequency pattern. Klank does not

disclose or suggest techniques for estimating the frequency offset or interleaver synchronization in an OFDM communication system, using differential decoding in frequency.

Van Nee has been cited by the Examiner for its disclosure of a digital modulation system that provides enhanced multipath performance using modified orthogonal codes. Van Nee  
5 does not disclose or suggest techniques for estimating the frequency offset or interleaver synchronization in an OFDM communication system, using differential decoding in frequency.

Dependent Claims

Dependent Claims 2-11, 13-21 and 23-28 were rejected under 35 U.S.C. §103 as being unpatentable over various combinations of Dejonghe, Rakib et al., Bohnke, Wood, Ohkubo,  
10 Klank and Van Nee. Claims 2-11, 13-21 and 23-28 are dependent on Claims 1, 12 or 22, and are therefore patentably distinguished over Dejonghe, Rakib et al., Bohnke, Wood, Ohkubo, Klank and Van Nee (or any combination thereof) because of their dependency from amended independent Claims 1, 12 or 22 for the reasons set forth above, as well as other elements these claims adds in combination to their base claim.

15 In view of the foregoing, the invention, as claimed in Claims 1-30, cannot be said to be either taught or suggested by Dejonghe, Rakib et al., Bohnke, Wood, Ohkubo, Klank and Van Nee (or any combination thereof). Accordingly, applicants respectfully request that the rejection of the claims under 35 U.S.C. §103 be withdrawn.

20 All of the pending claims, i.e., claims 1-30, are in condition for allowance and such favorable action is earnestly solicited.

If any outstanding issues remain, or if the Examiner has any further suggestions for expediting allowance of this application, the Examiner is invited to contact the undersigned at the telephone number indicated below.

The Examiner's attention to this matter is appreciated.

Respectfully submitted,



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